Chesapeake Biological Laboratory

Maryland Department of Research and Education

ANNUAL REPORT
1947

R. V. TRUITT

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Solomons Island, Maryland

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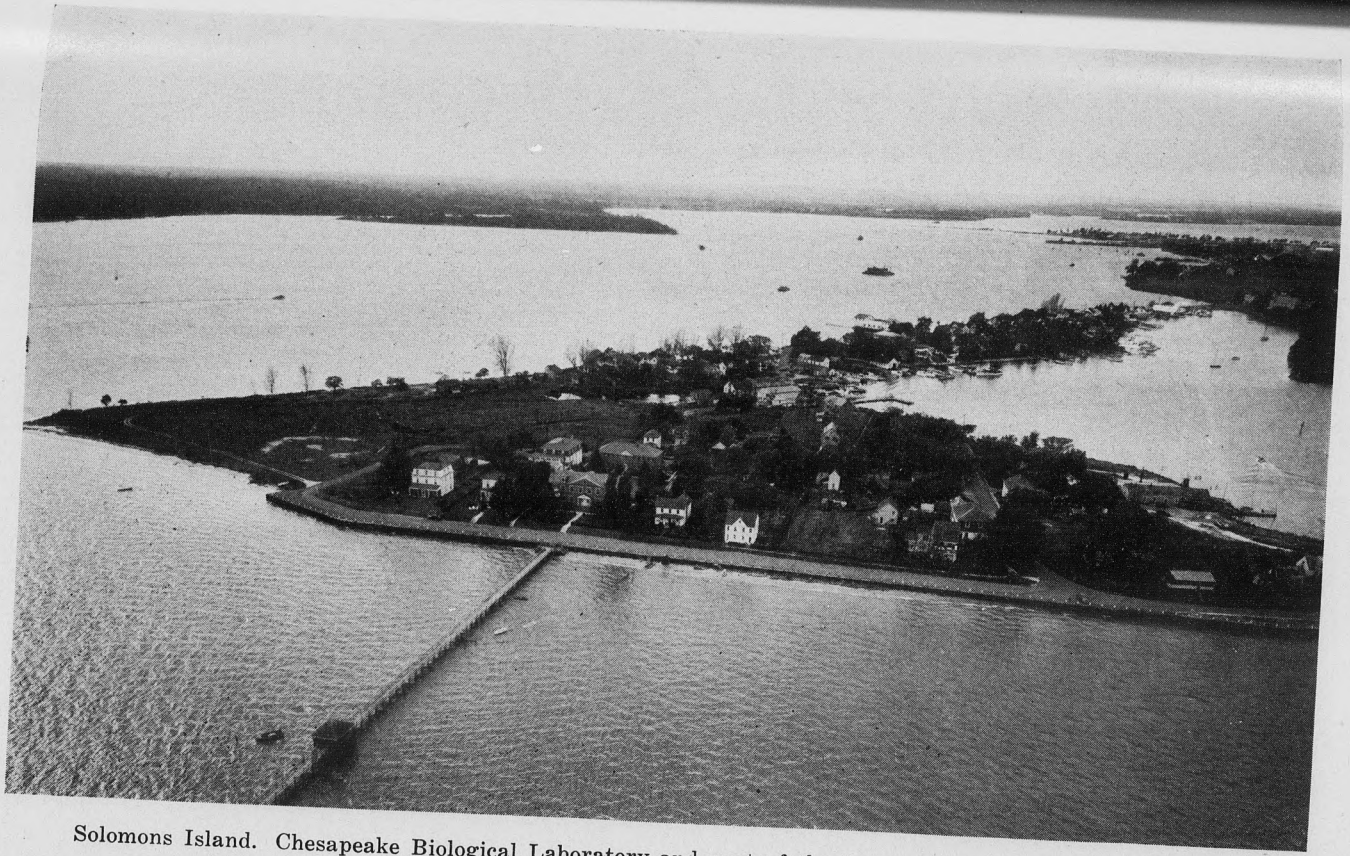


Solomons Island. Chesapeake Biological Laboratory and part of the Laboratory pier are in the foreground.

1947 REPORT OF
THE DEPARTMENT OF RESEARCH AND EDUCATION

A—GENERAL

This Department is concerned with an investigational and educational attack upon the problems of conservation. The policies and programs of the Department are determined by the Commission of Research and Education whose members are appointed by the Governor for staggered terms of five years each. The Commission is composed of five members who elect their own officers as follows: Dr. B. H. Willier, Head, Department of Biology, The Johns Hopkins University, *Chairman;* Mr. H. R. Bassett, Seafood Operator, Crisfield; Dr. Lloyd M. Bertholf, Dean, Western Maryland College; Dr. Ernest N. Cory, State Entomologist, University of Maryland; Prof. Franklin D. Day, Superintendent of Schools, Queen Anne's County, *Secretary.*

It has been the policy of this Commission to meet quarterly, or more often as circumstances require, and to place emphasis on those conservation problems which its members and the Board of Natural Resources consider of greatest importance in the development of the State. Abstract research is encouraged within the limits of this policy.

Because of the severe depletion of the fisheries and the urgent need for knowledge in this field, the Commission has continued to emphasize the problems of the Chesapeake Bay under the jurisdiction of the Department of Tidewater Fisheries. This Department is directed by law, however, to study all natural resources, except soils, and other agencies under the Board of Natural Resources have requested this Department to assemble factual information necessary for conservation administration.

The work of the Department embraces three major divisions in which the research is conducted at and from the Chesapeake Biological Laboratory, Solomons Island, the State Weather Service, with headquarters in the U. S. Customs House, Baltimore, and the educational program with offices at Solomons.

The Staff of the Department of Research and Education was:

DIRECTOR:

R. V. Truitt ..... Solomons Island

STATE WEATHER SERVICE:

G. N. Brancato, *Meteorologist in Charge*.....Baltimore

CHESAPEAKE BIOLOGICAL LABORATORY:

Edwin M. Barry, B.S., *Education Assistant*
G. F. Beaven, M.A., *Biologist I, Oyster Investigations*
Coit M. Coker, M.A., *Biologist II, Fishery Investigations, In Charge of Hatcheries*
L. Eugene Cronin, Ph.D., *Biologist II, Crab Investigations*
Alice W. Cronin, A.B., *Chemist III*
George B. Gray, B.S., *Administrative Assistant*
Harry A. Hensel, Jr., *Investigator*
Theodore M. Miller, B.S., *Fishery Technologist*
Harvey Mister, *Captain, Fish Culturist*
Lola M. Parks, A.B., *Librarian*
Fred W. Sieling, B.S., *Biologist II, Oyster Investigations*
Richard E. Tiller, M.S., *Biologist II, Fishery Investigations*
R. V. Truitt, Ph.D., *Biologist*
Doris M. Woodburn, *Secretary*

The program of the Department during 1947 included some new projects, while practically all of the major researches previously reported were continued and broadened. Included were intensive studies of: (a) certain impounded waters, (b) fishery by-products investigations, (c) pollution inquiries, (d) new biological and statistical sampling procedures, (e) surveys, (f) tagging tests, and still others, in addition to the continued intensive studies of fish, the oyster and the crab. In the educational program, the regular course, "Conservation of Natural Resources," was expanded to include four classes, in as many regions of the State, while a number of special-interest conferences and work shops was held in which the facilities of the Laboratory were used. A more detailed account of the program follows.

B—INVESTIGATIONS

1. FISH

The comprehensive statistical program set up in 1944 entailing the collection, tabulation and analysis of catch records from all licensed fishermen of Maryland was continued successfully during 1946-1947, with the result that complete and detailed returns were obtained from upward of 93% of all licensed fishermen. This program makes possible a complete yearly comparative analysis of the commercial landings of fin-fish in Maryland waters by species, fishing areas, and fishing gear. The inventory, besides being a valuable aid in the management of Maryland's fin-fish resources, makes available to the fishermen information as

to the condition of the industry. Biological studies of the fishery are also aided materially by the statistical survey.

Analyses of the 1946 records, the latest available, show an increased yield in most of the major species landed in the Chesapeake Bay region as compared with that of the preceding year. River herring, croaker and shad showed the largest increase, with minor gains in the catch of catfish, striped bass, white perch and yellow perch. The only declines were felt in the trout and spot populations. This condition is a complete reversal of the 1944-45 situation when an increase was shown for only the two species, trout and spot, and declines were felt in the other species.

The increase in Bay catch for the 1946 period was due, in part, to a higher yield of shad and herring in the upper areas. Honga River reported appreciable gains in the catch of croaker and herring. The Nanticoke, Pocomoke, Potomac, Fishing Bay and Tangier Sound areas all showed an increase in catch spread fairly evenly over all the major species. The central and lower Bay regions, the Choptank, Eastern Bay, Patuxent, Pocomoke Sound and Wicomico River areas, although reporting gains in some species, fell below their 1945 totals.

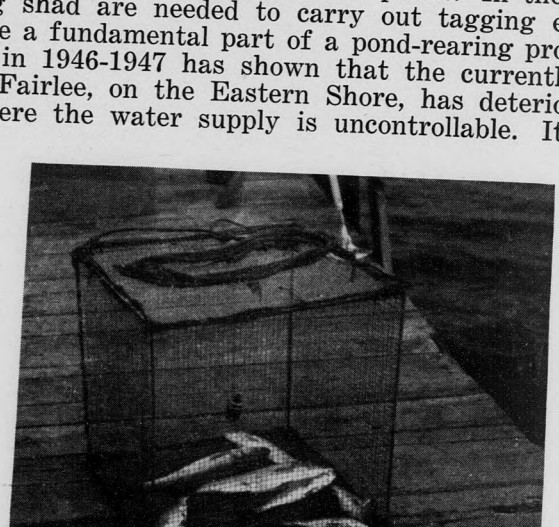
The 1946 season's output by the Atlantic Ocean fishery, centered at Ocean City, increased in volume to nearly double that of the 1945 season. Landing from pound nets in that area decreased somewhat from the 1945 figure. However, the fishery enjoyed a sizeable increase in the catch of fluke, Boston mackerel, porgy and whiting, due to landings by the record number of fishing boats that put into this growing port.

Operation of the commercial fish hatcheries during the Spring of 1947 was carried on effectively, yellow perch being hatched at the box system station near the head of Severn River, and shad in the experimental hatchery area of the North East River at Charlestown. Compared with 1946, the 1947 perch season was retarded by about ten days; water temperatures were appreciably lower throughout the period of spawning and hatching activities—a condition that appeared to have the beneficial effect of keeping down fungus attacks on the eggs and fry. Perch fry, numbering 151,920,000, were released in the various streams and bodies of water of all tidewater counties.

Shad hatching efficiency in 1947 again demonstrated the good quality of the North East River waters for the hatching of shad eggs. However, some difficulty was experienced in getting sufficient quantities of salvage shad spawn because of delay in ripening of the fish until the extreme latter part of the hatchery season. Fry produced at Charlestown (1,313,500) were released

in the North East River. Cooperative operations with the more modernly equipped U. S. Fish and Wildlife Service shad hatchery unit on the Potomac River were continued, and the resultant fry (3,251,000) from this source were planted in the Patuxent River.

Shad have been reared successfully in Maryland to fingerling stages in freshwater ponds through modified pondfish culture methods. Experimental research in this direction needs to be expanded to provide more efficient and economical procedures. Such research should be carried on in a manner whereby all of the important factors involved are controlled closely, requiring the construction of specially planned ponds. In the meantime, fingerling shad are needed to carry out tagging experiments which are a fundamental part of a pond-rearing program. Experience in 1946-1947 has shown that the currently available pond at Fairlee, on the Eastern Shore, has deteriorated to a point where the water supply is uncontrollable. It has additional disadvantages such as uninhibited predation and poor accessibility.



Special cage, 2′x2′x2′, used in studies of explosion effects. Living fish, oysters and crabs were tested in such cages. Note pressure recording gage in center.

Several cases of fish mortality that occurred at different times and at widely separated points were investigated during the year. Causes were found to be one or another of pollution, disease and explosives. In no case was the extent of the mortality of such proportion as to affect a fishery, although in one case the commercial fishery of a tributary of the Choptank River found it unprofitable to continue operations.

Studies of underwater explosion effects, in work carried on cooperatively with the Navy in the Patuxent River, were made at intervals during the summer of 1946 and the winter of 1947 on the basis of quantitative and qualitative counts of the fish kill in each case, to further determine possible injury. The charges used ranged in size from 300 to 1200 pounds. They were exploded in water depths ranging from 35-90 feet. During these seasons (summer and winter) the total visible fish kill per attended explosion was found not to be great in poundage and in several instances was zero. The apparent radius of affected area in all cases did not exceed 100 yards. Only when fish are schooled in the immediate vicinity of the firing area does the injury run to more considerable poundage. The data that have accrued from such observations over a three year period are being evaluated for publication in a forthcoming report.

Statewide sampling for juvenile fish, initiated some ten years ago, in which a small mesh haul seine is used, revealed minor variations in species abundance from area to area, but no definite sign of the occurrence of a strong year class of any commercially important fish.

In addition to hatchery work at Fort Belvoir, several other cooperative endeavors were carried on with the U. S. Fish and Wildlife Service. Shad scale samples from the spawning runs of the Susquehanna and Potomac rivers again were collected for study of Chesapeake shad population. Tabulation runs of Maryland catch-record statistics were made again by the Statistical Section in Washington. Arrangements were completed for joint work with the Fish and Wildlife Service in tagging of pond-reared shad to determine the percentage of survival of released fingerlings.

The investigation into the food habits of the upper Bay largemouth bass was continued with stomach samples taken during the late summer and early fall season. Sufficient samples were not obtained, however, to produce significant results.

During the season, a study was begun on daily temperature fluctuations of the shad-productive Susquehanna River several miles below the outlet of the Conowingo power dam. Preliminary study of records for the past two years shows that, for the spring and early summer months, the daily temperature fluctuations of the Susquehanna were similar in degree to those of the Patuxent River (at Solomons), but less frequent, over an equal number of days. The effect in the Susquehanna is attributed to the stabilizing influence of the impounded waters continuously released by the Dam during that period. Further expansion of this study is indicated for 1948 to cover periods when the flow may be more intermittent.

The special study of gonad development and spawning potential of female rock of various sizes is nearing completion. Ovaries have been collected by the fishery personnel of the Laboratory over the past few years and placed in the hands of Dr. H. W. Jackson of the Virginia Polytechnic Institution, who initiated the study, for analysis.

Study was initiated on the croaker several years ago by the Department. Some of these data dealing with sexual development in the adults and distribution of the early stages in the Bay, were published in 1940. A volume of additional data, including length-weight ratios, length-frequency measurements, and some tagging results, remain to be interpreted and worked up into a form suitable for presentation. The original investigator commenced organizing this material in 1947 in order that gaps of knowledge could be determined and a program organized to fill the gaps. It is planned to continue biological work on the croaker looking not only toward working out its complete life history, but to determine the effect of the commercial fishery on the spawning stocks.

It is estimated that some 10,000,000 pounds of fin-fish waste materials are being thrown away annually in Maryland. This waste and that of the other fisheries is of high potential value in fine chemical manufacture, pharmaceuticals, foods, and a variety of other uses. Recognizing these facts, the Department of Research and Education, during the past year, has undertaken to investigate the possibilities of utilizing fishery waste materials in a manner which would benefit those directly concerned by augmenting the income of fishermen and processors. The investigation included consultation with fishermen and packers, surveys of the scientific literature, discussions with local Chesapeake manufactures, experiments in preparing, packing and handling raw materials, and contacts with industrial manufacturers along the Eastern Seaboard. As a result of the general findings and of the interest aroused among both potential suppliers and potential utilizers of waste raw materials, a program was evolved, "The Utilization Plan—Maryland Marine Products," which is aimed at helping to develop a stable supply and demand for by-products of the fishery industries. The Plan is described fully in the publication, Educational Series, No. 14, issued May, 1947.

Considerable experimentation was carried on in cooperation with industry in developing better methods of preparing, packaging, and handling the main fish product, as an outgrowth of studies of by-product utilization. This work was pointed toward increasing the keeping qualities and providing a tastier, more

appetizing and appealing product, the findings from which will be announced in a forthcoming separate publication.

2. OYSTERS

The oyster investigation program of the Department was continued during the year relative to (1) intensity and time of spat fall on test shells, (2) commercial set on State shell plantings, (3) population of oyster bars, (4) distribution and abundance of natural enemies, (5) season and rate of attachment of fouling organisms on shells, (6) growth and mortality of seed oysters, and (7) condition of oysters throughout the year. Accumulation of data has contributed greatly to an understanding of the normal setting and growing conditions for oysters on many bars of the State and has helped to bring about a more effective operation of the State's program of shell and seed planting.

The summer of 1946 was marked by below normal temperature and salinity of the water at Solomons Island followed by a gradual return to normal conditions in the fall. Oyster growth and condition were excellent in that region, although poor in the upper Bay area where continued below-normal salinities during most of the growing season prevented recovery from the severe setback suffered by oysters there during the 1945-46 oyster season.

Mild fall and early winter temperatures together with approximately normal salinity conditions favored oyster growth during the first half of the 1946-1947 oyster season. Index of condition data on bars near Solomons Island showed that local oysters reached their peak of fatness from December to February. Water temperatures at the Solomons Station remained above 5°C until the end of January and oysters were found generally with *style* and food present in the stomach at that time. Oysters were observed to be fairly fat as far up the Bay as Kent Island. In the Tangier area they retained considerable amounts of spawn well up into the winter and failed to develop the normal amount of glycogen or "fat" present when overwintering.

February and March of 1947 were considerably colder than normal, and water temperatures lower than average continued through spring into summer. Salinity remained high until June when a sharp drop occurred. Oyster condition and spring growth were good in the Patuxent River and in the Chesapeake area near Solomons where there was some delay in the ripening of gonads.

Bags of clean test shells exposed weekly in the Bay near Solomons, during 1946, collected a few spat during the latter part

of June, and a set of approximately 900 spat per bushel in mid-July. Another set of approximately 550 per bushel occurred during mid-August and a few more set in mid-September. Old cultch on the bars in this area, however, had a commercial set of only 24 spat per bushel in October of that season. Light setting commenced in the same area during the second week of June, 1947.

Test bags were exposed at two locations in Tar Bay during 1946. They acquired a total catch of 1575 spat per bushel over a period from early June to late September. Peak setting occurred here also in mid-July. Observations in St. Mary's River section were rather irregular, but on recovered test bags a cumulative count of 20,600 spat per bushel was found at Seminary Wharf. A count of 5,950 was recorded on Gravelly Run, a figure that covers only a portion of the setting season since numerous bags were not recovered.

The oyster drill population in Tangier Sound, although still low, became increasingly active during 1946 as evidenced by drilled oysters and egg case clusters. Damage during the season was not great except to the spat in the lower portion of the Sound, but the presence of drills as far up as Haines Bar continued a potential threat to new spat sets should salinities become high enough to favor growth of the drills. Drills and drill egg cases again were found during the first half of 1947. The young oysters from the set of 1945, however, appeared to be sufficiently large to prevent serious losses from this source since drills more typically attack thinner shelled spat or barnacles.

A heavy set of barnacles again occurred in the Solomons area during November 1946, followed by moderate setting in December and January. The spring set of this organism was the heaviest and latest thus far observed, with a peak occurring from mid-May to mid-June. Gathering of records on the abundance of this and other fouling organisms throughout the State was continued. Such data are becoming increasingly valuable in guiding the shell and seed planting programs of the State.

Observations on a number of experimental seed plantings in Chincoteague Bay were terminated during 1946 and 1947. The oysters used were moved from water with salinities generally ranging from 10 to 15 into Chincoteague Bay water where salinities ranged around 30 at the time of transplantation. The data gathered are not conclusive, but are indicative of the following generalizations applicable to oysters transplanted under the conditions indicated: (1) Large oysters planted in mid-summer do not grow as rapidly during that season as do similar spring planted oysters and often make "retrogressive growth", that is, lay down a new bill some distance back of the former growing edge

so that at the end of the growing season the average size is less than that at the time of planting. (2) When fat oysters are transplanted they undergo less mortality and resume growth earlier than do poor oysters. (3) Small yearling seed oysters grow more rapidly than the larger sizes, but suffer much more severely from drill damage so that few survive to reach market size. (4) Oysters transplanted from fresher water take up salt rapidly and in twenty-four hours, with some shrinkage of the body, possess essentially the same salt content as acclimated oysters. (5) Fat oysters planted during the fall readily adjust themselves to the salinity change and make satisfactory "Chincoteague Oysters" during that season. (6) Oysters transplanted after water temperatures are low enough to check normal feeding activity rapidly accumulate a band of mud over the gills which render them unmarketable and results in severe mortality.

No unusual mortality of oysters in the Chesapeake area occurred during the period July 1, 1946 to July 1, 1947. However, in Chincoteague Bay oyster losses again were high and their condition was poor in most of that region. These losses appeared to be associated with heavy mats of drifting algal growths which settle on and overlay the beds for long periods. These masses of algae often become compacted when decomposition sets in, and deposits of silt collect more readily in the algae than on the open bottom. Oyster drills are generally abundant in this area and, aside from damage to planted oysters, they destroy the spat which set there typically in great numbers.

Determination of the condition of oysters from certain key bars in the lower Patuxent area has been made by the chemist in cooperation with the oyster research workers. The establishment of this "condition factor", which entails measurement of volume of oyster, volume of shell cavity, weight of wet and dried meats, requires bi-weekly samples of twenty oysters from each bar under observation. This program was begun in the early spring of 1946 and is projected as a long range study.

Experimental study of the comparative growth of typical seed secured from different sources was initiated in the Spring of 1947. Groups of 500 young oysters from each of a number of well known seed areas, ranging from Connecticut to North Carolina, were placed on special wire trays elevated slightly above the bottom and planted side by side so that they had essentially the same environmental conditions. The individual oysters were measured as to length and width at the time of planting. Successive periodic measurements are to be made for two or more years. It is expected that from these observations considerable light will be thrown on the question of whether or not oysters from diverse areas may possess inherent differences in rate of growth.

Tray containing oysters used in growth studies.

Such information will have practical value both to the State and to private planters.

3. CRABS

The exact nature and causes of the great fluctuations in the supply of Chesapeake blue crabs have not yet been determined. They continue to present the major problem in the conservation and best use of this animal, and to form the core of present investigations of the species. The Department has furthered certain crab investigation of its own and has participated actively

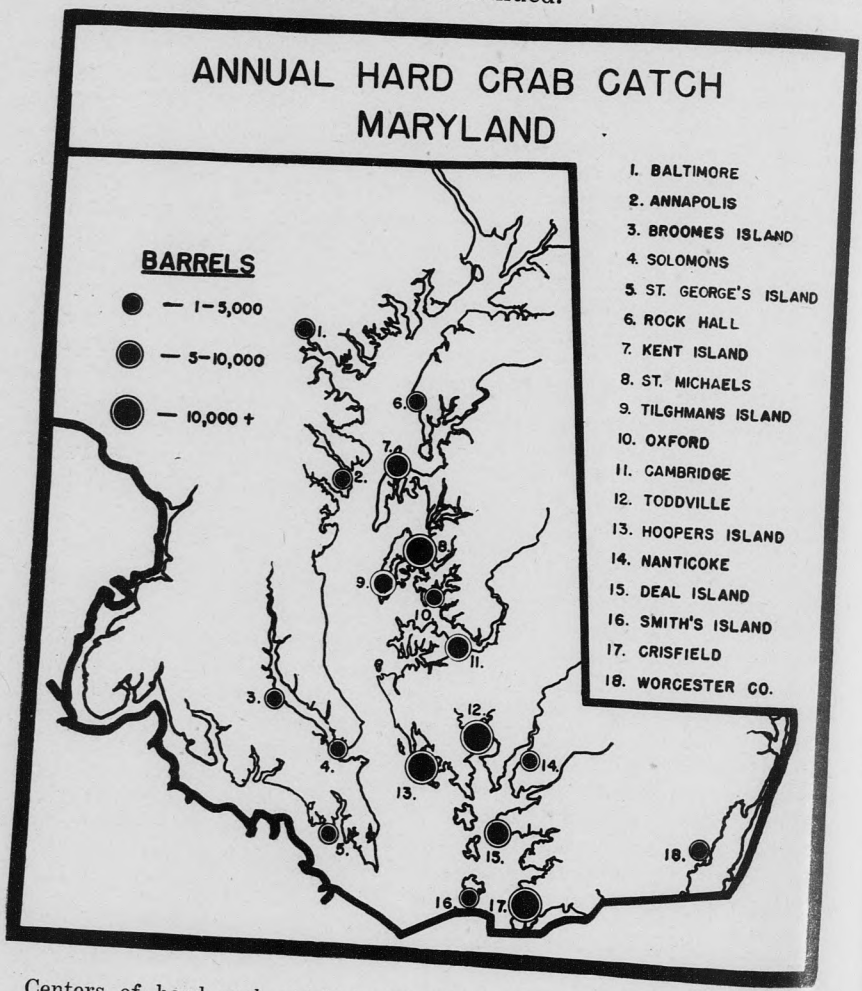
in the cooperative studies sponsored by the Chesapeake Section of the Atlantic States Marine Fisheries Commission.

The cooperative crab program has included several important activities. The U. S. Fish and Wildlife Service crab investigator presented a report which strongly suggests that river flow onto the crab spawning area greatly affects the number of crabs growing to legal size, although the mechanism of this effect is not indicated or understood. The report has had at least two far-reaching results. It has redirected attention to the great importance of environmental conditions in determining the production and survival of this species as well as of many others. It also has brought about the creation of a Blue Crab Technician Committee composed of representatives from the Service, the Maryland and Virginia laboratories, and the Atlantic States Commission. This committee has been charged with (1) preparation of recommendations for administrative guidance and (2) planning and executing a long-term research program. The committee has met and held intensive discussion of many phases of crab knowledge and research, including (a) the factors which might decrease the supply of crabs, (b) the importance of river flow and of brood stock, (c) required investigations, (d) the very serious need for adequate catch statistics, and (e) the most effective use of the limited personnel available for research on the crab. The efforts of the Department have been closely associated with the work of the Technician Committee. Methods for the quantitative and the qualitative analysis of the crab population present in any one area or in several areas have been improved, tested, and put into operation at several centers of the industry.

The study of seasonal changes in the kind and quantity of crabs present in an area has been applied to four crab centers: Fishing Bay, Tilghman's, Secretary, and Rock Hall. To this end, three steps are necessary: (1) Determination of the average catch per man per day, in pounds, for each week throughout the season. This is made from the daily catch records of a group of carefully chosen average crabbers in the area. (2) Approximation of the kinds of crabs present each week in the area. This is made from weekly samples obtained by a careful commercial crabber. (3) Combining the catch records and the quantitative samples for each week to estimate the number of mature and immature males and females available to each crabber each day throughout the season. The major trends of increase or decrease in each kind of crab are estimated from this.

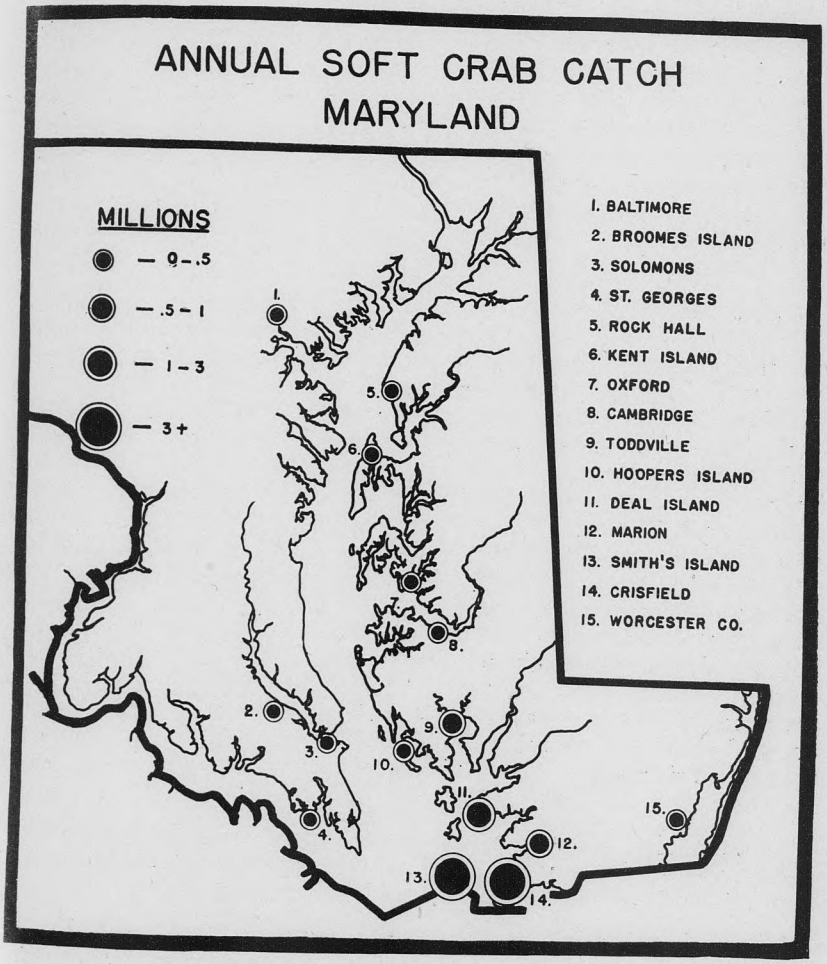
Fishing Bay yielded a fair but not spectacular catch in 1946. The average daily catch rose from about 125 pounds per day in early June to 250 pounds per day in mid-July, dropped slightly

in early August, and then increased to and held at about 275 pounds per day through September. The combination of these figures with quantitative sampling showed that small male and female crabs were not particularly abundant in early June, but increased to large number in late June and early July. Large males increased to their maximum abundance of 650 per day in mid-July, then decreased steadily. Mature females showed a small increase in early July, and in early August they suddenly trebled in number and remained abundant until the end of September when sampling was discontinued.



Centers of hard crab catch in pre-War years. Average of seasons, 1929-1941.

Records from near Cambridge showed several differences in trends. The daily catch was good in the early season and near average in August and September. Immature crabs were extremely plentiful in May, declined throughout June, increased in July and fell off in August and September. Mature males increased from 400 per day in early June to 1000 per day in early July, fell to 225 per day in late August and increased to about 400 at the end of September. Mature females decreased in abundance to about 225 per day in June, rose to 450 and fell to 200



Centers of soft crab catch in pre-War years. Average of seasons, 1929-1941.

per day in July, then increased throughout August to about 600 in September.

Tilghman's Island is a most important point for the study of crab populations in Maryland. It is situated just above the bottleneck, between Cove Point and Taylor's Island, through which all crabs must pass in entering or leaving the upper Bay. One operator, the Tilghman Packing Company, buys crabs from the same group of trot-liners every year, and has kept all of its daily catch records since 1925. These records have been made available for the purposes of this study.

Tilghman's was used as a testing area for the quantitative and qualitative methods in the summer of 1946. A separate report is being prepared to present the details of the method and the statistical analyses of the data, which clearly delimit the usefulness of the methods. The daily catch at Tilghman's was well above average in May, June and July, but dropped below the 20-year average in August. It increased in late August and September, as usual, but remained slightly below average for those months.

The quantitative sampling again provides data on the number of the different kinds of crabs available per man per day throughout the season. According to the samples, the following trends occurred. Four to six hundred small males were caught per day in May, followed by a decrease to about 300 in late June and early July. A marked increase occurred in late July and August, and reached a peak of 700-800 per day in late August. The catch dropped suddenly to 300 per day in early September. Large males, over 5 inches wide, increased from 450 per day in May to a peak of over 900 in mid-July, and declined to about 300 per day in late August and September. Immature females were abundant in early May, decreased to 100 per day at the end of June, increased to 400 per day in mid-August, and decreased to 250 per day in September. Mature females were almost absent from the catch in May, increased suddenly to 500 per day in July, dropped to 200 per day in late July and August, and then increased steadily through August and September. When sampling was discontinued in late September, some 500-600 were being caught.

Quantitative samples also were taken at Rock Hall. No crab house operated there in 1946, however, thus accurate figures can not be developed on the population trends.

These data, which are tedious in written form, can be plotted clearly in graphs. An important series of observations for 1946 has been accumulated. Such data supply part of the needed information on mass migration and on local fluctuations which

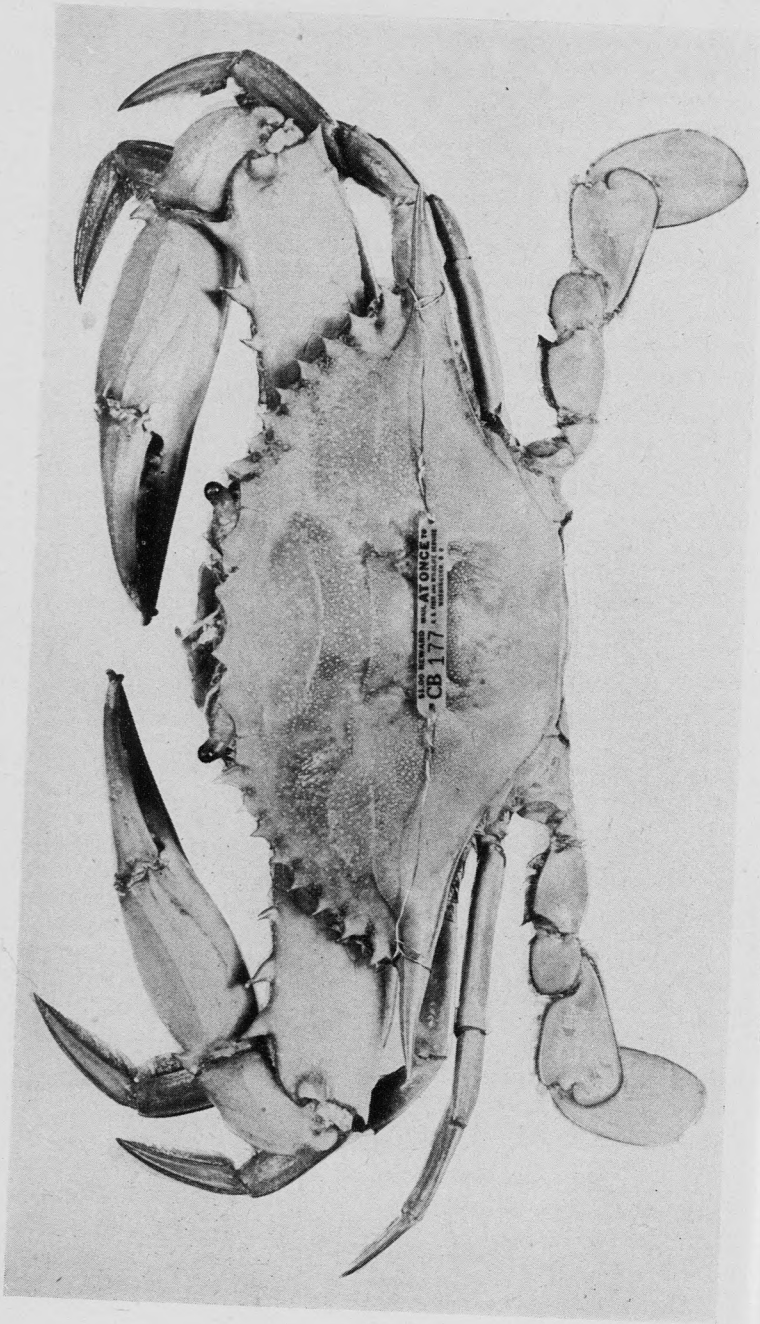
must be gathered and interpreted over a series of years from many points before conservation practices can be based entirely on factual data. This intensive local sampling at a number of crab centers will be improved, expanded and coordinated as fully as possible with the studies being made in other parts of the Bay by Virginia and by Maryland.

The Department is now maintaining the records of soft crab daily catch initiated in 1942 by the Fish and Wildlife Service. These data may be useful in early predictions of the abundance of hard crabs, thus of value to Maryland and Virginia packers.

Local samplings can not possibly yield all of the facts required for full understanding and sound management of this species. Ideally, accurate estimates must be made of the total number of animals produced, the number which die, either naturally or by being caught, and the number left each year to reproduce. Part of this can be learned from total statistics on the commercial catch by all crabbing gears in all parts of the Bay. Accordingly, the Department is introducing an improved catch record system which will yield a record of the daily catch of every commercial crabber in the State. Every packer or shipper is to be provided with a bound ledger in which to keep his regular records. At the end of each week, a carbon copy of the names of his men, the gear they used, where they crabbed, and the number of pounds caught each day will be sent to the Department. The form of the ledger was worked out with commercial packers and should be useful to the crab houses and adequate for research needs.

Several other investigations were continued or completed in 1946. Tagging of crabs continues to add important facts to the knowledge of migration and rate of capture. An improved strap tag made of brilliant red plastic was introduced. The tag is attached by stainless steel wire as pictured herein. It carries notice of a $1.00 reward, a serial number, and the address of the Fish and Wildlife Service. The obverse carries the words, "State when and where caught or when and from whom purchased." The Service forwards the tags to this Department for payment and to be processed. This type of tag is yielding far better returns, averaging 20-30 per cent of those released. A separate report will summarize the efficiency of various types of tags which have been used as well as the biological data from the returns.

The study of the anatomy of the adult male reproductive system was completed. The blue crab system is more complex than that of any previously described species of decapod crustacea. Sperm are grouped into sperm bundles or spermatophores which are transferred to the receptacles of the female at the time of mat-



Blue Crab bearing type of tag now used in the Chesapeake Bay.

ing. These sperm are stored for many months within the female before they are utilized at the time of spawning.

The collection of mud crabs from many parts of the Bay has been examined at the U. S. National Museum through the courtesy of Drs. Waldo Schmitt and Fenner Chace of that institution. Six species are recorded from the Bay: *Eurypanopeus depressus* (Smith), *Rhithropanopeus harrisii* (Gould). *Hexapanopeus angustifrons* (Benedict and Rathbun), *Panopeus herbstii* Milne Edwards, *Neopanope texana sayi* (Stimpson), and *Eurytium limosum* (Say). The first two named mud crabs are far more abundant in the Chesapeake than any of the others. Data will be presented in a separate report on the distribution, abundance, and biology of these species in relation to salinity, temperature, depth, type of bottom, etc. An interesting species of *E. depressus* was noted on which the right maxilliped, just in front of the mouth, had become modified to form a tiny but apparently perfect claw or chela.

The effect of DDT on waters containing fish and crabs was partially investigated, since that chemical is being used widely in the control of mosquitoes. Spraying considerably greater than normal commercial applications were made over fish and crabs held in a net in 7½ feet of water of a salinity of about 15 parts per thousand in which 5% DDT oil emulsion and 30% DDT in a water soluble carrier were applied. All fish and crabs appeared to be in normal condition for six days following the experiment.

The sudden and severe decline in the catch of crabs in the Chincoteague Bay and nearby waters was investigated on a limited basis, but no understanding was achieved. At the end of July, the daily catch per man dropped within a few days from about 400 pounds to 50 pounds, and no real recovery occurred during the remainder of the season. No catastrophe, serious pollution, or other sudden change could be associated with the decrease. The biology of the species in these shallow coastal waters is not well understood, and it is not possible to assign this drastic change in supply to oceanward migration, to failure of the hatch of the previous year, or to any other single factor.

Research is planned on several new projects for the summer of 1947. They include (1) methods of stimulating "green" peelers to shed on an economically sound basis, (2) the development of a crab pot which will permit the escape of all undersized crabs, (3) permanent tagging of immature crabs so that the tags will be retained through the shedding process and (4) the use of semi-artificial bait for catching crabs in pots.

Blue Crab bearing type of tag now used in the Chesapeake Bay.

4. DIATOMS

Special study of diatoms was continued during the year through the cooperation of the Smithsonian Institution in which Mr. Paul S. Conger was assigned to the Cheasapeake Biological Laboratory for the summer period. A considerable part of this study consisted of extending the survey of the Cheaspeake Bay diatom flora which has been under observation during the summers for several years. In addition, collections were made and analyzed from Chincoteague Bay and from various deposits and banks in the Calvert County area. Examination of plankton samples from the mouth of the Patuxent and Potomac rivers was made at weekly intervals, approximately. Limited sampling was done in Tangier Sound and in the tidal pools on the marshes of Worcester County.

Diatoms constitute a significant part of plankton, the food of oysters. Identification of diatoms from the stomach contents of oysters was continued. Study was made of the succession of epiphytic diatoms of water weeds in the vicinity of the Laboratory pier, and experiments were conducted on the growth of single diatom cells in water on special culture slides. Special habitats were observed for diatoms, such as the blue crab, crab floats and Limulus, while exceptional masses of a particular form, *Rhabdonerna adriaticum*, were studied, found growing in shallow water and on marine vegetation in Chincoteague Bay. An important feature of the studies during the season was the special attention given to the movement of diatoms, about which much remains to be known. Mr. Conger, in addition to participating in the Department's educational program through discussion, demonstration and exhibits, made certain contributions to the development of new diatom collections and experimental equipment.

5. FRESHWATER ALGAE

Periodic samplings of different bodies of fresh water in Maryland were made throughout the year to determine the algal flora. One small swamp pond at the head of the Bush River estuary was examined at least twice a month through 1946 to 1947.

The number of algae determined during the period of the survey combined with the number identified in previous years makes a total of 582 species known for the State. Among them are 38 species not previously reported for the United States while there are eight new records of rarer species. Seven genera and 19 species are to be reported as new to science. Records for the different classes of algae are set forth in the table on page 19.

6. HYDROGRAPHY

The hydrographic program was not resumed in full during the

	Orders	Families	Genera	Species	Varieties
MYXOPHYCEAE	3	7	30	69	.....
XANTHOPHYCEAE	4	8	13	19	.....
CHRYSOPHYCEAE	5	8	16	25	.....
CHLOROPHYCEAE	8	32	109	317	44
EUGLENOPHYCEAE	1	2	6	45	2
CHLOROMONADOPHYCEAE	1	1	1	1	.....
CRYPTOPHYCEAE	1	1	2	3	.....
BACILLARIEAE	2	4	5	6	.....
DINOPHYCEAE	4	7	17	37	.....
CHAROPHYCEAE	1	1	2	9	.....
RHODOPHYCEAE	1	3	4	5	.....
TOTAL	31	74	205	536	46

year because of lack of adequate boat facilities and inability to secure the services of a specialist in the field. Bi-weekly station samplings, however, were maintained in the lower Patapsco River area throughout the year. Observations were made daily at the tide station on the Laboratory pier. Weekly sampling was continued in the channel of the Patuxent River off Solomons, the analyses of which added to the already accumulated data on surface and bottom waters for dissolved oxygen, salinity, temperature, and plankton populations. Samples also were taken at various times elsewhere in the waters of the State in the furtherance of the fin-fish, crab and oyster research programs.

Chemical studies during the year included: determinations of chlorinity, pH, dissolved oxygen and total iron content of water from the Patapsco area; dissolved oxygen determination for the Conowingo Pool survey; measurements of salinity made periodically on water from various oyster bars and from important crabbing areas; and checks for oxygen, pH and salinity from areas reporting mortality of aquatic life. Requests for testing of water samples from areas suspected of pollution were complied with by the chemist in charge.

7. CONOWINGO SURVEY

A survey of the Conowingo Pool, an extensive artificial body of water formed by the construction of a power dam across the lower

Susquehanna River in 1928, was initiated in March, 1946 looking to a comprehensive understanding of the physics, chemistry and biology of the area. This body of water, as appears to be the typical development from such impoundments, was reported at first to be productive of sport types of fish and then its productivity declined until very low yields were realized. Immediately pertinent to the problem of fish abundance or scarcity are data bearing on dissolved oxygen, temperature, turbidity, plankton and the kind and abundance of fishes present. Study of these factors to date is not conclusive because of its limited nature, thus is given here a preliminary account of the work and the data accrued from it.

Dissolved oxygen was found to be present from the surface to the bottom of the reservoir. The extremes were 5.4 p.p.m. and 11.6 p.p.m. The average of dissolved oxygen from surface to bottom was 9.3 p.p.m. The amount of dissolved oxygen probably reflects the high degree of aeration obtained, sometimes by spill-over at the up-stream Holtwood Dam, but more continuously in the zone of rapids between Holtwood and the Pool.

The temperature extremes during 1946 were 0°C during the winter months and 37.6°C during the summer period, i.e., August. The temperature of the water was taken daily at elevation 35 (60 foot depth) by the Conowingo Power Plant. This depth is at the upper third of the intake for the generators so the water passing through has some admixture of upper strata with the bottom water. The data from this source show that the water temperature correlates closely with the average daily air temperature.

Temperatures taken at one mile intervals by means of a bathythermograph show the same correlation. These data also indicate a rapid fluctuation in the thermocline level; a fluctuation accounted for in part by the "straight channel" nature of the reservoir, and by the fact that the water, for power, is drawn from the reservoir bottom. The effect of bottom draw-off is shown by the accumulated data when continuous temperature lines are drawn through the plotted surface to bottom temperature curves for the first five stations. The temperature strata dip markedly at the fourth range and decline toward the base of the dam. The effect of heavy local showers and of masses of water released at Safe Harbor dam is shown also by such plottings. The temperature masses move down stream essentially intact.

The turbidity, daily records being available, is understandably high during the spring floods, occasionally reaching 400 p.p.m.; but, generally varying between 100 and 250 p.p.m. during that period. By the latter part of March, turbidity is down to 10

p.p.m., and during the summer months it remains at 5 p.p.m. or less. These records constitute a sensitive index of soil erosion in the local water shed during the summer period.

Plankton has been found abundant in the Conowingo Pool, there being 400,000,000 cells per liter at times. There is a relative constant population of three species of diatoms—two species of *Melosira* and one of *Asterionella*. Along with this population, there appear to be several successions of algae and protozoan blooms. Notable among the algae have been members of the Chlorococcales, of which *Pediastrum* spp. was the dominant member of the bloom; Diatom blooms with *Asterionella* predominant, and *Chrysosphaerella* second in abundance; and, *Dinoflagellata* blooms with *Ceratium* predominant. There also were Rotifer blooms and combined Rotifer and Dinoflagellate blooms. The population of crustacea appears to be relatively constant during the summer and early fall. *Daphnia, Nauplius* and *Cyclops* are some of the common genera represented.

Netting to determine the kinds and the abundance of fishes was carried on in which 1½ and 2 inch mesh gill nets were used. Fyke and hoop nets were tested and shown to be ineffectual because of the ground and bottom obstructions. Fishing was conducted in coves, in the open reservoir, along the shore, at the surface and near the bottom at several stations, but due to the large quantity of floating debris common to such a river, gill netting was difficult, thus this part of the survey is relatively incomplete.

The fish taken during the study are listed below in descending order and by a ratio based on the total catch of game fish for the period. This listing does not necessarily reflect the true order of prevalence since the selectivity of the mesh size may have imposed an artificial prevalence picture.

Game fish taken:

12	Crappie (*Pomoxis nigro-maculatus*)
6	Walleyed Pike (*Stizostedion vitreum*)
3	Small Mouth Black Bass (*Micropterus dolomeiu*)
2¾	Large Mouth Black Bass (*Huro salmoides*)
2½	Blue Gill Sunfish (*Lepomis macrochirus*)
2	Rock Bass (*Ambloplites rupestris*) (Red-eye)
1	Pumpkinseed Sunfish (*Eupomotis gibbosus*)
½	Yellow Perch (*Perca flavescens*)

Other fish caught:

16	Catfish (all kinds)
3	Redhorse sucker
1	Black Sucker or Mullet
¼	Dace or Golden Shiner

Carp were present, but rarely caught in the net.

Length and weight data were kept on all of the catches, and scale samples were taken from the fish. These data are in process of correlation.

The Conowingo survey, as indicated, has not been completed. Continued sampling is to be made both for additional data concerning the fish and for a picture of the trend in natural propagation in the reservoir.

8. OTHER STUDIES

A number of isolated less prominent studies was conducted in the Department during the year. These included observations on specific organisms, both plant and animal, as to their number and distribution, as a part of the faunal and floral survey of the State. Cooperation was continued with the U. S. Maritime Commission in the exposure of steel panels to further long time observations on anti-fouling paint combinations. Observations were made on fresh-water impoundments relative to fish productivity, while further tests were made on pond fertilization in connection with the rearing of fry to larger sized fingerling shad.

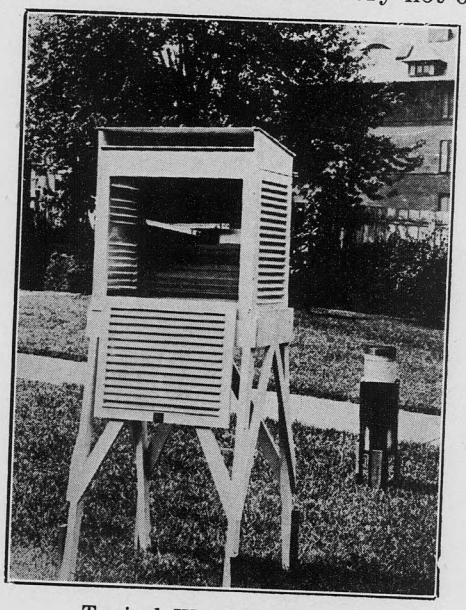
The Patapsco project, an overall study directed to the determination of the quality and condition of the river at all seasons of the year, was reinvigorated and expanded to become a major study during the summer of 1947, and on for a three year period. The results of this study, made possible through industrial grants, are intended to throw considerable light on the wisest possible use of the Patapsco River in the conservation program. In addition, certain streams of the State were investigated during the year to determine their condition as aquatic environments, and in an effort to ascertain possible sources and kinds of pollution in those cases where untoward disturbances were found to exist.

The personnel of the Department was called upon to investigate a number of instances where mortality had taken place, especially among the fin-fish, mainly a summer-time development. Such studies required much time and effort on the part of the investigators. They have not, in the main, been highly successful due to the fact that typically dead animals, chiefly fish, are reported and not dying ones. The time lapse between the lethal period that kills and the surfacing of bloated fish is most often such as to make possible complete disappearance of the adverse factor such as, for example, carbon-dioxide tension. Analyses were made of many water samples taken in the researches on oysters, fish and crabs, apart from mortalities, in order to evaluate the areas in terms of potentialities for resource development.

In addition to the study made looking to the production of an artificial crab bait, already reported, tests were made in an effort to provide a substitute or semi-artificial bait for eels in the trapping program. Middle and Magothy Rivers were treated separately in limited studies to determine the fish carrying capacity and brood stock reserve of these bodies of water. In cooperation with the U. S. Navy, further study was made of the underwater detonation effects of explosives on marine resources. Members of the Staff participated in the Annual Bird Census through covering the local region to record by species and numbers the abundance of birds as a part of a continuing Country-wide project. Still less important studies in progress are not enumerated here, some of which serve to round out the major investigations.

C—WEATHER SERVICE

Collection of data on weather in the State is the function of the Maryland Weather Service, an integral part of the Department of Research and Education. The Service's field work is conducted by cooperating highly interested observers who work on a voluntary basis and without pay. Some seventy stations fairly well distributed over the area from the seaside to the western end of the State are operated throughout the year in order to provide basic data for weather predictions of a comprehensive nature. Such records over a wide territory not only make fore-



Typical Weather Station.

casts possible but they provide information on climatic conditions that are of help to the farmer, that throw light on underground and surface water supplies and that contribute to the comfort and health of the public.

A typical weather station of the type used (see illustration) consists of a thermometer shed, constructed along lines that have been proved effective in the U. S. Weather Bureau, and a separate metal rain gauge mounted on a stand. Records covering the following weather factors are made daily: temperature, air movement, degree of cloudiness and precipitation (the accrued data from which is filed weekly with the central office in the Custom House, Baltimore), together with certain farm crop information. Here the data are recorded and, with those over a broader territory, interpreted for forecasting and general use. Such a service makes it possible to evaluate the climate as a resource in connection with temperature means and extremes, rigors, degree-day, invigorating qualities, and growing seasons. These factors affect the lives of people, their industries and the problems of plant and animal culture. In this connection, the records show that Maryland occupies a highly favorable position.

D—EDUCATION

The attempt to develop a conservation consciousness in the State of Maryland has been greatly intensified through the coordinate effort of the Department and all of the agencies concerned with natural resource planning and development, together with large segments of the State's educational leadership. Emphasis on in-training and in-service teacher programs was continued through offering a three-hour credit course by qualified members of the Board of Natural Resources, in which the University of Maryland participated not only in the field of soils but by providing college credit for the work at the advanced undergraduate-graduate level. Six classes were organized during the year at the following named points: College Park, Westminster, Bethesda, Frederick and Baltimore. Instruction was provided to 127 in-training and in-service teachers. It is estimated that through these classes, more than 5,000 Maryland children received specific instruction in the appreciation and understanding of the existing conservation situation.

A number of conferences was held during the year with the officials of the State Department of Education which resulted in State-wide plans for continuing resource-use education beyond the Junior High School level. The Education Assistant, Department of Research and Education, acted in a consulting capacity in producing a resource bulletin on conservation for the Junior High Schools of Maryland, which bulletin, planned and produced

at the State Teachers' College Workshop at Towson, was used throughout the State during 1946-47.

Use was made of the Chesapeake Biological Laboratory and dormitory facilities of the Department during the year to provide short courses for many groups interested in learning about the State's conservation program, including teachers, sportsmen, college faculty, civic, political and enforcement organizations. Among these groups were a curriculum study committee, Seniors of Towson State Teachers' College, Montgomery Elementary School Science teachers, delegations of legislative bodies, Maryland Commercial Fishermen's Association, summer workshops, and others. Registrants in the accredited course were required to observe and study first-hand the conservation problems of water, geology, soils, forest, game and fish for which weekend field trips to demonstration areas were provided under highly competent leadership.

The staff of the Department continued to meet increasing requests for lectures and demonstrations in the several fields of interest pertinent to the research and education program, and to the conservation movement in the State—this being especially true in connection with civic organizations and the more formal educational groups. The members continued to serve as technical advisers with local conservation groups and organizations, public and private. Many meetings were held with representatives of neighboring states and the Federal arm in order to cooperate with and co-ordinate the work of existing agencies with overlapping problems, and to effect an exchange of ideas and techniques looking to the advancement of the conservation effort in general.

A long recognized need in the dissemination of conservation information has been for visual aids for adult and for school programs. Few states have attacked conservation education problems with greater vigor and determination than has Maryland, and few have done less to take advantage of the camera, movie and still, for this purpose. During the year a comprehensive presentation of the marine resources and the problems inherent in them was made possible through the use of some ten panels, 10′ x 4′, done in color, in black and white and by means of actual demonstration materials, very useful and instructive aids where sufficient space is available. A library of 35mm color slides is now being developed.

The effectiveness of the education effort of the Department is traceable, in no small degree, to the recognition, on the part of the public school leadership, of the need for presentation of conservation information to the school children. Implementation of the

program has had the support from the beginning of Dr. Thomas G. Pullen, State Superintendent of Schools, and the officials associated with him. That office and those of the County Superintendents continued to approve the course, "Conservation of Natural Resources," for "teacher certification," as well as to encourage teacher participation in the program and the use of conservation materials where they are best suited to the class room, mainly in social studies.

E—PUBLICATIONS

Several publications based on the researches and the educational work of the Department were issued during the year. These, together with certain earlier unreported ones, are listed below. With the increase in literature needed to meet the conservation education program, it was deemed advisable to start a new series, *Education Series*, in which such matter is now being placed. Contributions of a scientific nature are being continued in the *Publication Series*. Following are the publications listed by series, number and title:

Publication
No.

57 Indications of Compensatory Growth in the Striped Bass, *Roccus saxatilis* Walbaum, as Revealed by a Study of the Scales. 1943. Richard E. Tiller

58 The Larvel Stages of the Calanoid Copepod *Eurytemora hirundoides* (Nordquist). 1944. Charles C. Davis.

59 Ebullition of Gases from Marsh and Lake Waters. 1944. Paul S. Conger

60 Maryland Commercial Fish Hatchery Operations. 1943, 1944. Ralph C. Hammer

61 On Four Species of Copepoda New to Chesapeake Bay, with Description of a New Variety of *Paracalanus crassirostris* Dahl. 1944. Charles C. Davis

62 Histochemical Observations on Glycogen in the Liver of the Blue Crab, *Callinectes sapidus* Rathbun. 1944. Sister Leonide Regan

63 A Survey of the Bryozoa of Chesapeake Bay. 1944. Raymond C. Osburn

64 Environmental Characteristics of a River Estuary. 1947. Carroll B. Nash. Jour. Mar. Res. Vol. VI, No. 3

65 Some Observations on Seasonal Variations in Plankton Population, Patuxent River, Maryland, 1943-45. 1947. Dorothy Clum Morse

66 Anatomy and Histology of the Male Reproductive System of *Callinectes sapidus* Rathbun. 1947. Lewis Eugene Cronin. Reprint Jour. of Morphology, Vol. 81, No. 2, September, 1947

67 Fresh-water Dinoflagellates of Maryland. 1947. R. H. Thompson

68 Effect of Susquehanna River Stream Flow on Chesapeake Bay Salinities and History of Past Oyster Mortalities on Upper Bay Bars. 1947. G. Francis Beaven

Educational
Series No.

1 The Maryland Fishery Management Plan. 1944. R. E. Tiller

2 The Maryland Management Plan and the Rock Fishery. 1944. R. E. Tiller

3 Maryland Laws Governing Natural Resources. 1944
4 Symposium. 1944. Maryland Conservation Forum
5 The Maryland Management Plan and the Shad Fishery. 1944. R. E. Tiller
6 Fishery Management Plan Productive. 1944. R. E. Tiller
7 The Oyster. 1944. R. V. Truitt. Reprinted from *Bios*. Vol. XV. No. 3. October, 1944
8 Maryland's Oyster Problem. 1945. G. F. Beaven
9 Maryland Stream Flow Records. 1945. Joseph T. Singewald, Jr.
10 Officials and Organizations Concerned with the Conservation of Natural Resources. 1945.
11 Maryland Commercial Fish Hatchery Operations. 1946. Ralph C. Hammer
12 Trees of Maryland. 1946. Joseph F. Kaylor
13 Ground Water in the Baltimore Area, Maryland. 1946. Robert R. Bennett
14 Utilization of Marine Products. 1947. Theodore M. Miller
15 Maryland Commercial Fishery Hatchery Operations, 1946-1947. Coit M. Coker
16 Annual Report, 1946. 1947. R. V. Truitt

The research publications of the Department are distributed widely in the field of biology and to the reference libraries of America and abroad. The educational bulletins are in numerically larger issues and, apart from those that go to professional workers, are distributed where they serve their intended purposes, particularly among the people who work in and with the natural resources, and in the field of education State-wide. The demand for such material in the class rooms of Maryland is very great.

A six-page periodical, *Maryland Tidewater News*, is issued monthly to all persons licensed to take resources from the Chesapeake Bay, the processors of such resources and to the school and public libraries, especially those of Maryland. This publication carries information relative to the status of the different fisheries, indicates the progress, or otherwise, of fishery management programs, points out the activities elsewhere, as well as locally, of fishery leaders and the progress they are making in conservation. Also, it emphasizes the goals of sound conservation whether marine or highland, and it provides considerable factual information for readers at the several levels reached by it.

The Department's library at the Chesapeake Biological Laboratory is receiving, through exchange or otherwise, research and conservation publications from similar agencies in this country together with many foreign issues, as a result of which an expanding, comprehensive list of references is available to the workers in the different fields. This material is being bound as far as practical in order not only to preserve it but to simplify its use.

F—ACKNOWLEDGMENTS

Many individuals and agencies contributed to the work of the Department during the year in all areas of activity. Mr. Paul Conger again pursued studies in the important branch of Botany, the diatoms, through assignment of the Smithsonian Institution, which Government agency continued to provide information of a taxonomic nature concerning many of the forms taken in the different surveys. The U. S. Navy, through the Ordnance Laboratory and the Office of Naval Research made possible further observations on detonation effects of explosives in local waters. Also, through conditional transfer of the former Amphibious Training Base, Solomons Island, to the State, needed space and facilities are to be provided for the work of the Chesapeake Biological Laboratory.

The survey of the Conowingo Pool was aided materially by Mr. Paul LeFever, Superintendent, and Mr. Robert Turner, Hydrographer, of the Conowingo Power Plant who made available to the worker in charge long-continued as well as current records, facilities and certain equipment.

The Virginia Fisheries Labobratory and the Chesapeake Biological Laboratory cooperated freely and heartily in consultation and in the field on common problems of the Bay, a most wholesome and mutually beneficial relationship on the part of the two agencies. The Fish and Wildlife Service continued its coordinative effort in the Chesapeake crab researches, aided in the Maryland hatchery program, furthered shad studies in the State and intensified its part of the joint oyster investigation program. Also, the Service's personnel cooperated freely in the State's wildlife program, analyzed fish and other forms in an effort to determine causes of mortality, received the tags returned from released crabs, provided tabulations of the Department's fishery statistical data, together with certain clerical and mailing help, and conferred and advised with this and other State conservation agencies upon request.

Mr. E. P. Roane, Oyster Planter, Williamsburg, Virginia, generously loaned to the Laboratory a sufficient number of iron trays, one bushel capacity, with which to further a feature of the oyster investigations. The Harbor Engineer's Office, City of Baltimore, provided on a cooperative basis adequate boat facilities and crews to meet the fortnightly requirements of the Patapsco River Project. All of the departments of the Boards of Natural Resources contributed freely to provide the Course, "Conservation of Natural Resources", in the six classes, as did the Maryland Soil Conservation Committee.

Dr. Thomas G. Pullen, State Superintendent of Schools, and

the County Superintendents enthusiastically continued the promotion of conservation education in the School System of Maryland and gave credit for the work in certificate renewal. The Course was accredited in the University of Maryland and certain other institutions of the State at the advanced undergraduate-graduate level.

The contributions from the several individuals, agencies and institutions indicated here were not only marked and of very considerable value in furthering the Department's research and education programs, but they indicated the growing interest in and concern for the accumulation of factual conservation information and the dissemination of same for the common good. The Commission and the Staff of the Department of Research and Education recognize the important part this cooperation played in furthering the work of the Department and they deeply appreciate the many considerations, tangible and intangible, that were given to this segment of the conservation program of Maryland.

R. V. TRUITT,
Director